DYNAMICS OF RIPARIAN VEGETATION: THE EXAMPLE RUMEX STENOPHYLLUS LEDEB.

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Dedicated to Prof. REINHOLD TÜXEN (1899-1980)

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RÉSUMÉ
La dynamique de la végétation de bord des fleuves de l'Europe centrale est représentée par l'example de *Rumex stenophyllus* LEDEB. Cette espèce de rumex continentale s'a agrandi le long des bords de l'Elbe plus loin vers le nord. *Rumex stenophyllus* peut germer sous l'eau; les plantules peuvent exclusivement s'établir au littoral. Comme la comparaison des relevés, que REINHOLD TÜXEN publiait des memes sections de bord, indique, *Rumex stenophyllus* s'ádapte aux *Bidentetea* comme *Xanthio albini-Chenopodietum rubri* et *Rumicetum maritimi*, sans changer leur structure.

SUMMARY
The dynamics of the riparian vegetation of Central European rivers are shown by the example of *Rumex stenophyllus* LEDEB. This continental dock species has spread along the Elbe up to the north during the last decades. *Rumex stenophyllus* is able to germinate under water, the seedlings are able to establish along the riverbanks. A comparison with relevés from the same riverbank sections published by REINHOLD TÜXEN shows that *Rumex stenophyllus* becomes part of *Bidentetea* communities like *Xanthio albini-Chenopodietum rubri* or *Rumicetum maritimi* without any change in their structure.

INTRODUCTION

REINHOLD TÜXEN was very interested in riparian and nitrophilous vegetation. In 1950 he published his famous „Grundriß der nitrophilen Vegetation der Eurosibirischen Vegetation Europas“, he also was the first who describes the nitrophilous skirt communities. At the example of river valleys he developed the Sigma Sociology. His last book deals with Bidentea tripartitae, mainly at the rivers Weser and Elbe (TÜXEN 1979).
Therefore I want to discuss briefly the changes in the riparian vegetation of the river Elbe since 1979. A detailed investigation of the riparian flora along the part between the Bohemian highlands and Lauenburg (600 km) showed 86 neophytic species (BRANDES & SANDER 1995). Their dynamics are very strong; in the last years, on avarage, one species per annuum is spreding.

The following species occur in *Bidentetea* communities:

Amaranthus bouchonii
Amaranthus cruentus
Amaranthus emarginatus
Amaranthus powellii
Amaranthus retroflexus
Artemisia annua
Artemisia biennis
Atriplex micrantha
Atriplex sagittata
Bidens connata
Bidens frondosa
Brassica nigra
Cuscuta campestris
Eragrostis albensis
Galinsoga ciliata
Lycopersicon esculentum
Panicum capillare
Polygonum lapathifolium ssp. danubiale
Rumex stenophyllus (fig. 1)
Xanthium albinum

Two of them are „neo-endemics“: *Eragrostis albensis* and *Xanthium albinum*. Species marked by an asterix are not documented by plant sociological relevés before 1980 (e.g. WALTHER 1977, TÜXEN 1979). Nevertheless, REINHOLD TÜXEN (1979) pointed out that *Artemisia annua* and *Amaranthus* spec. are spreading along the river Elbe. Till now we studied ecology and population biology of *Artemisia annua* (BRANDES & JANSSEN 1991, MÜLLER 1996, MÜLLER & BRANDES 1997), *Atriplex micrantha* (BELDE, MÜLLER & GRIESE 1995), and *Xanthium albinum* (BELDE 1996). This paper continues our work on invasive plants; the investigated areas are the riverbanks of the Elbe in Niedersachsen (Lower Saxony) and Sachsen-Anhalt in Germany.

RUMEX STENOPHYLLUS: DISTRIBUTION AND ECOLOGY

The primary area of this continental dock species is Sibiria, Central Asia, Eastern Europe as well as the south–eastern Central Europe (RECHINGER in HEGI 1957/58). The Flora Europaea (TUTIN et al. 1993) counts *Rumex stenophyllus* for the following countries: Russia, Romania, Jugoslavia, Hungary, Austria, Czechoslavakia, Germany. For Germany an isolated occurence in the area of the lower part of the river Saale near the city of Bernburg is known for some time. The areal diagnosis of *Rumex stenophyllus* is m-temp•kEURAS (ROTHMALER 1996). LAASIMER et al. (1993) gave additional records for Estonia and Latvia, there are also some records for Western Europe and North America.

According to BENKERT, FUKAREK & KOSCH (1996) there is a significant accumulation in the eastern part of Germany along the middle part of the river Elbe and its affluent Saale. In all probability our species spread from the area of Bernburg along the Saale river banks to the Elbe. In 1982 it was first found at the lower-saxonian river banks of the Elbe (MÜLLER & KALLEN 1988). It may be, that in former times *Rumex stenophyllus* was confused with the hybrid *Rumex conglomeratus x Rumex obtusifolius*, which shows only low fertility.

The germinules of *Rumex stenophyllus* are brown nuts about 2 mm small, their weight is about 0,98 mg (the weight per 1000 grains is 0,984 g). The seeds show high germination capacity and germinate also under water. Seedlings are able to survive when submerged, whereby they of course stay as seedlings. According to our investigations, these submerged seedlings are able to establish and grow at the river banks if the conditions are favourable (fig. 2; BRANDES & EVERS 1999). This ability to germinate under water allows the species to spread very effective along rivers. Further investigations are necessary to clear up the role of water pollution by salt and heavy metals to the spreading of *Rumex stenophyllus*.

PLANT SOCIOLOGY OF *RUMEX STENOPHYLLUS*

Rumex stenophyllus typically grows at very muddy, mostly low-lying areas between groynes, the core of which is often built up by the *Cypero fusci-Limoselletum aquaticae* (OBERD. 1957) KORNECK 1960. *Rumex stenophyllus* forms assemblages with *Rumex maritimus*, an annual dock species. Most of the stands of *Rumex stenophyllus* belong to the subassociation of *Rumex maritimus* of *Xanthio albini-Chenopodietum rubri* LOHM. et WALTHER in LOHM. 1950 (table 1). Relevés published by REINHOLD TÜXEN (1979) are compared with our relevés from the same area in table 2. The comparison shows clearly, that *Rumex stenophyllus* fits very well in an established community without any alteration in the structure. *Impatiens glandulifera* shows a similar behaviour, whereas *Reynoutria japonica* (= *Polygonum cuspidatum*) or *Helianthus tuberosus* displace their competitors from riparian habitats (LOHMEYER & SUKOPP 1992). *Rumex stenophyllus* grows also together with *Bidens radiata* in the *Rumicetum maritimi* (table 3).

In contrary to our observations OBERDORFER (1994) classified *Rumex stenophyllus* as very rare species of *Agrostietalia*, occurring on saline habitats. Only a few years ago we found *Rumex stenophyllus* in assembleges with other *Agrostietalia* species.

Steep slopes of the dike near Wahrenberg (Sachsen-Anhalt). 2. 7. 1995. Height of *Rumex stenophyllus*: 100 - 110 cm. Area: 60 m², vegetation cover: 85 %:

Agrostietalia: 3.3 *Elymus repens*, 2.2 *Agrostis stolonifera*, 2.2 *Plantago intermedia*, 2.2 *Rorippa sylvestris*, 1.2 *Alopecurus geniculatus*, 1.1 *Rumex obtusifolius*, + *Ranunculus repens*, + *Trifolium hybridum*;
Molinio-Arrhenatheretea: 1.2 *Phleum pratense*, + *Trifolium repens*;
Bidentetea: 1.2 *Bidens frondosa*, 1.1 *Xanthium albinum*;
others: 1.2 *Phalaris arundinacea*, + *Rorippa amphibia*, + *Leonurus marrubiastrum*.

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Fig. 1: Rumex stenophyllus (left) with Xanthium albinum on the banks of the river Elbe near Pevestorf (Lower Saxony, Germany).

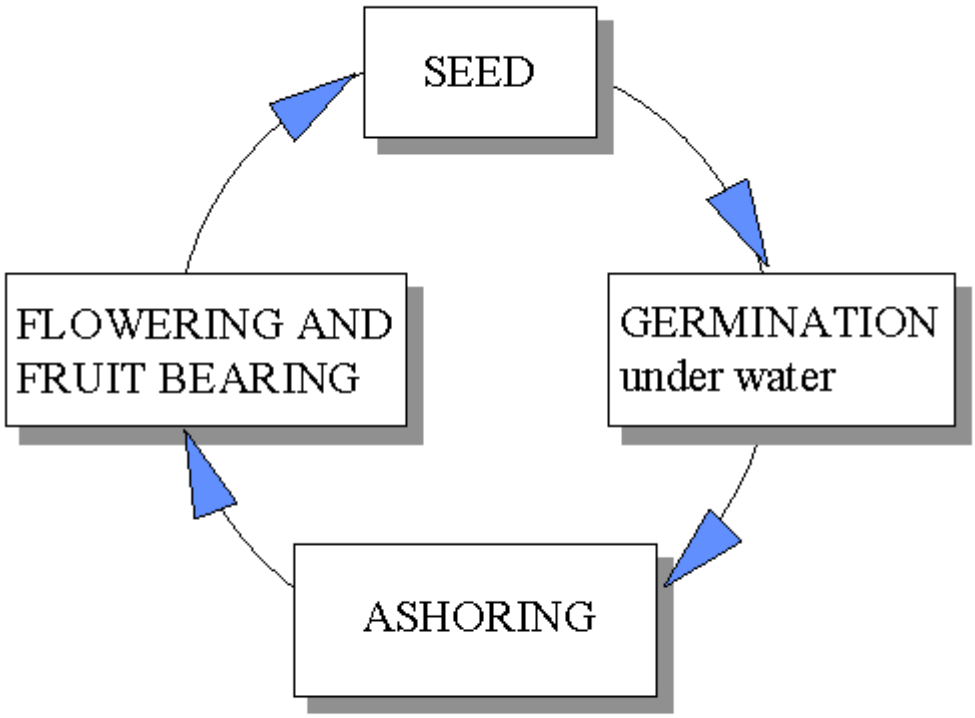

Fig. 2: Life-cycle of Rumex stenophyllus with subhydric germination (schematic diagram).

Tab. 1: Xanthio albini-Chenopodietum, subassociation of *Rumex maritimus*

Relevé no.:	1	2	3	4	5	6	7	8	9	10	11	12	13
Surface [m²]	35	10	40	20	25	20	40	30	30	15	30	8	25
Covering [%]	90	95	90	98	75	80	100	60	80	70	90	98	95
Number of species	18	15	13	17	17	18	13	25	26	19	23	18	21
AC Xanthio albini-Chenopodietum:													
Xanthium albinum	+	3.3	3.2	2.2	3.3	2.2	.	3.2	2.1	3.2	2.1	2.2	3.2
D Subass. von Rumex maritimus:													
Rumex stenophyllus	4.4	2.2	3.2	4.3	2.2	2.2	1.2	3.2	2.2	2.2	2.1	2.2	2.2
Rumex maritimus	1.2	2.2	3.2	2.2	.	3.2	2.2	+	+	.	1.1	1.2	2.2
Chenopodion rubri:													
Artemisia annua (D)	1.1	+	1.1	1.1	+	1.1	+	1.1	1.1	2.2	+	+	1°.1
Chenopodium rubrum	+	1.1	1°.1	1.2	1.2	1.2	+	1.2	1.1	+	1.2	.	+
Tripleurospermum inodorum (D)	+	2.2	+	r	+	+	1.1	+	+	1.1	1.1	.	+
Chenopodium glaucum	+°	1.1	+	1.2	1.2	1.2	+	1.2	1.2	1°.2	.	.	+
Atriplex prostrata	+	1.1	+°	+°	+.2	1.1	+	1.2	1.2	.	+	1.1	.
Chenopodium ficifolium (D)	+	1.2	.	.	1.2	.	.	.	+	+.2	.	.	.
Chenopodium polyspermum	.	1.1	+	.	.	.	.	1.2	1.1	.	.	.	.
Amaranthus emarginatus	.	.	.	.	.	.	.	+	1.1	+	+	.	+
Erysimum cheiranthoides	.	.	.	.	.	.	.	+	.	+	+	.	+
Corrigiola litoralis	.	.	.	.	2.2	1.2	.	+	.	.	.	.	.
Polygonum brittingeri	.	.	.	.	.	.	.	.	.	1.1	.	+	+
Artemisia biennis	+	.	.	.	.	.	.	.	.	.	.	.	.
Spergularia echinosperma	.	.	.	.	.	+	.	.	.	.	.	.	.
Portulaca oleracea (D)	.	.	.	.	.	.	.	+	.	.	.	.	.
Eragrostis albensis	.	.	.	.	.	.	.	.	.	1.1	.	.	.
Bidentetalia and Bidention:													
Polygonum lapathifolium	2.2	3.3	1°.1	2.2	2.2	2.2	4.5	2.2	4.3	2.2	1.1	1.1	3.3
Bidens frondosa	+	.	.	+	.	.	+	1.1	1.2	.	+	+	+
Pulicaria vulgaris	.	.	.	.	+	1.2	.	.	+	.	2.2	2.2	2.2
Rorippa palustris	.	.	.	.	+.2	+	.	.	.	+	+.2	.	.
Echinochloa crus-galli	.	.	.	.	.	.	.	1.1	1.2	+	.	.	+
Ranunculus sceleratus	.	.	.	r.	.	.	.	.	.	.	+°	2.2	.
Bidens radiata	.	.	.	.	.	.	.	+	.	.	.	.	.
Epilobium ciliatum	.	.	.	.	.	.	.	.	.	.	+	.	.
Bidens tripartita	.	.	.	.	.	.	.	.	.	.	.	+	.
Others:													
Plantago intermedia	3.3	2.3	3.3	2.3	2.3	3.3	2.3	+	1.2	1.2	1.2	2.2	1.2
Gnaphalium uliginosum	+	.	+.2	+	+.2	+.2	.	+	+	+	+	.	.
Rorippa sylvestris	.	.	.	.	2.2	2.2	+	+	.	+	1.1	+ .2	1.2
Phalaris arundinacea	1.2	2.2	1.2	+	1.2	.	1°.1	.	.	+	.	.	.
Salix alba et spec. juv.	.	.	.	+	.	.	.	.	1.1	.	2.3	2.3	2.2
Rumex obtusifolius	+	.	.	.	.	.	+	.	1.1	.	.	1.1	.
Leonurus marrubiastrum	.	2.2	.	1.1	.	.	.	.	.	.	.	+	.
Polygonum aviculare agg.	.	.	.	.	+	+	.	.	.	.	.	.	+
Taraxacum officinale	.	.	.	.	.	.	.	1°.1	+	.	.	.	r
Lythrum salicaria	1.2	.	.	.	.	.	.	.	.	.	.	.	+
Capsella bursa-pastoris	.	+	.	.	.	.	.	.	.	+	.	.	.
Populus nigra juv.	.	.	.	.	.	.	.	r	+	.	.	.	.
Sonchus asper	.	.	.	.	.	.	.	.	+	.	r	.	.
Juncus compressus	.	.	.	.	.	.	.	.	+	.	.	1.2	.
Chenopodium album .	.	.	.	.	.	.	.	.	.	.	.	1.2	r

Also in No.1: + *Solanum dulcamara*; No.4: r *Conyza canadensis*; No.6: + *Poa anuua;* No.8: + *Senecio viridis,* r° *Arctium spec. K.*; No.9: + *Lycopus europaeus*, r *Urtica dioica,* r *Poa palustris*; No.11: + *Spergularia rubra,* +.2 *Juncus bufonius*; No.13: +.2 *Limosella aquatica.*

Tab. 2: Xanthio albini-Chenopodietum, subassociation of Rumex maritimus: comparison between pre-1979 and 1998

Source	Tüxen (1979)		Brandes	
Number of relevés	14		13	
Number fo species per relevé	17		19	
AC Xanthio albini-Chenopodietum:				
Xanthium albinum	V	+-5	V	+-3
D Subass. of Rumex maritimus:				
Rumex maritimus	V	i-2	V	+-3
Pulicaria vulgaris	IV	i-2	III	+-2
Invasive species:				
Rumex stenophyllus	.		V	1-4
Artemisia annua	.		V	+-2
Amaranthus emarginatus	.		II	+-2
Eragrostis albensis	.		+	1
Artemisia biennis	.		+	+
Portulaca oleracea	.		+	+
Epilobium ciliatum	.		+	+
Chenopodion rubri:				
Chenopodium rubrum	V	+-5	V	+-1
Atriplex prostrata	V	+-3	V	+-1
Tripleurospermum inodorum	V	+-2	V	+-1
Chenopodium glaucum	III	+-2	V	+-1
Chenopodium polyspermum	III	+-1	II	+-1
Chenopodium ficifolium (D)	III	+-2	II	+-1
Polygonum brittingeri	II	+	II	+-1
Erysimum cheiranthoides	I	1[i]	II	+
Spergularia echinosperma	i	+	+	+
Corrigiola litoralis	+	+	II	+-2
Bidentetalia and Bidention:				
Polygonum lapathifolium	V	1-4	V	1-4
Bidens frondosa	V	+-1	IV	+-1
Bidens tripartita	III	r-+	+	+
Echinochloa crus-galli	IV	+-2	II	+-1
Polygonum hydropiper	II	+-1	.	
Rorippa palustris	I	+-1	II	+
Ranunculus sceleratus	I	+	II	r-2
Bidens ceruna	+	+	.	
Polygonum minus	+	+	.	
Bidens radiata	.		+	+
Others:				
Plantago intermedia	III	r-2	V	+-3
Rorippa sylvestris	III	i-2	IV	+-2
Gnaphalium uliginosum	III	r-1	IV	+
Polygonum aviculare coll.	III	i-1	II	+
Plantago major coll.	III	+-2	.	
Rorippa amphibia	III	r-1	.	
Phalaris arundinacea	II	+-1	II	+-2

Tab. 3: Rumicetum maritimi Sissingh ex. R. Tx. 1950

Relevé no.	1	2	3	4	5
Surface [m²]	20	30	30	30	30
Covering [%]	100	100	100	100	100
Number of species	18	13	16	15	14
AC Rumicetum maritimi:					
Bidens radiata	2.2	2.1	2.2	1.1	2.2
Rumex maritimus	2.1	1.2	2.2	2.1	1.2
D Variant of *Rumex stenophyllus*:					
Rumex stenophyllus	1.1	1.1	1.1	1.1	1.1
Bidentetea:					
Polygonum lapathifolium	4.4	4.4	4.4	4.4	5.5
Bidens frondosa	1.2	1.2	1.2	1.1	1.2
Echinochloa crus-galli	2.2	2.2	1.1	1.1	1.2
Bidens tripartita	1.2	1.2	.	+	1.2
Ranunculus sceleratus	1.2	1.1	+	1.1	.
Pulicaria vulgaris	1.1	.	1.1	+	.
Alopecurus aequalis	1.1	.	.	.	.
Chenopodium glaucum	r°	.	.	.	.
Xanthium albinum	.	.	+	.	.
Tripleurospermum inodorum	.	.	.	.	r
Others:					
Typha latifolia	1.1	1.1	2.1	1.1	2.2
Plantago intermedia	1.2	2.2	2.2	1.2	1.2
Limosella aquatica	1.2	1.2	1.2	1.2	1.2
Salix alba Keiml.	1.1	+	1.2	+	.
Alisma plantago-aquatica	+	.	+	1.1	.
Phalaris arundinacea	.	1.2	+	.	1.2
Polygonum aviculare agg.	1.1	.	.	1.2	.
Lythrum salicaria	+	.	.	.	+
Sagittaria sagittifolia	.	.	+	.	.
Poa palustris	.	.	.	.	+

All relevés 1998 from the orographic left river side of the river Elbe (TK 2934/2).